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# *Visually decomposing vehicle images: Exploring the influence of different aesthetic features on consumer perception of brand.*

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*This paper presents a technique to investigate the influence of aesthetic features and brand recognition of vehicles. Visual aesthetics have been shown to impact greatly on consumer perception of products and their branding, yet there exist few tools or methods to support reasoning about their influence. To explore this influence, a procedure for visually decomposing designs into constituent aesthetic features is developed. The strategy is applied to a range of saloon cars, and a consumer survey undertaken to establish the significance and potency of individual aesthetic features. Results both validate the decomposition technique and highlight certain aesthetic features which have the greatest influence on brand recognition.*

Keywords: aesthetics, automotive design, design tools, reasoning, styling

## *1 Introduction*

It is known that visual aesthetics play an important role in the successful consumption of products (Bloch, 1995; Moulson & Sproles, 2000; Page & Herr, 2002). Audi states that up to 60% of a consumer's decision to purchase a vehicle is based on styling rather than technical performance (Kreuzbauer & Malter, 2005). In the same way that aesthetics can influence consumer judgment, so can brand. What is more, perceptions of product brand influence judgments of quality and overall desirability and are primarily derived from the product appearance (Bloch, 1995; Page & Herr, 2002). Consequently, visual aesthetics become an important consideration during the design process. In industries such as automotive, where technological advances are becoming less of a differentiator between competing products, the role of visual aesthetics becomes even more crucial to a vehicle's success in the marketplace (Warell, Stridsman-Dahlström, & Fjellner, 2006).

The complex nature of vehicles compared with other mass produced products (such as household products and consumer electronics), along with lengthy design and development times (3-4 years(Thomke, 2001)), mean they require considerable investment from manufacturers. With this investment comes considerable financial risk relating to the success or failure of vehicles when launched onto the market. Thus, during the design and development process there is great pressure on designers and managers to make correct and well informed judgements. While, in many design problems there are methods and strategies that can help designers to evaluate designs and make informed judgements (Lockamy & Khurana, 1995; Ulrich & Eppinger, 2008), assessment of visual aesthetic qualities remains highly subjective and ill defined. Designers and managers concerned with this aspect of vehicle design must rely on previous experience and training and the notion of designer's intuition when considering visual aesthetics of design proposals, despite the impact these judgements can make on the vehicle's market success (Moulson & Sproles, 2000).

This research aims to support designers and managers involved in vehicle styling by providing a tool to help reasoning on the perceived brand associated with a design's visual aesthetic. This paper reports the primary steps towards the development of such a tool by creating a procedure for visually decomposing designs such that the aesthetic features may be identified and assessed, and their influence on brand recognition explored. Section 2 discusses background to the process of vehicle design and the role of aesthetics and branding in a product's design. This background contextualizes the principal aim of the overall research programme and the ensuing specific aim of the work reported in this paper (section 3). Section 4 includes a review of previous work that has used visual decomposition in order to explore constituent parts of visual material. The decomposition strategy adopted for the current study is also set out and discussed in section 4 and the methodology for implementing and testing the decomposition strategy is described in section 5. Results are presented (section 6) then discussed (section 7) and conclusions drawn in section 8.

## *2 Background*

This section presents the background to the subject of aesthetics in vehicle design and considerations of brand management during the design process. In discussing research into the design process and the way designers work, Lawson ( 2006) states that a better understanding of the nature of design and the characteristics of design problems and their solutions is required. Through the discussion of the background, a clear definition of the research problem and thus the aims of this study and how they will be accomplished is proposed. This section introduces the processes followed to generate the aesthetic aspects of a vehicle's design and the use of visual aesthetics in product design.

### *2.1 Design development process*

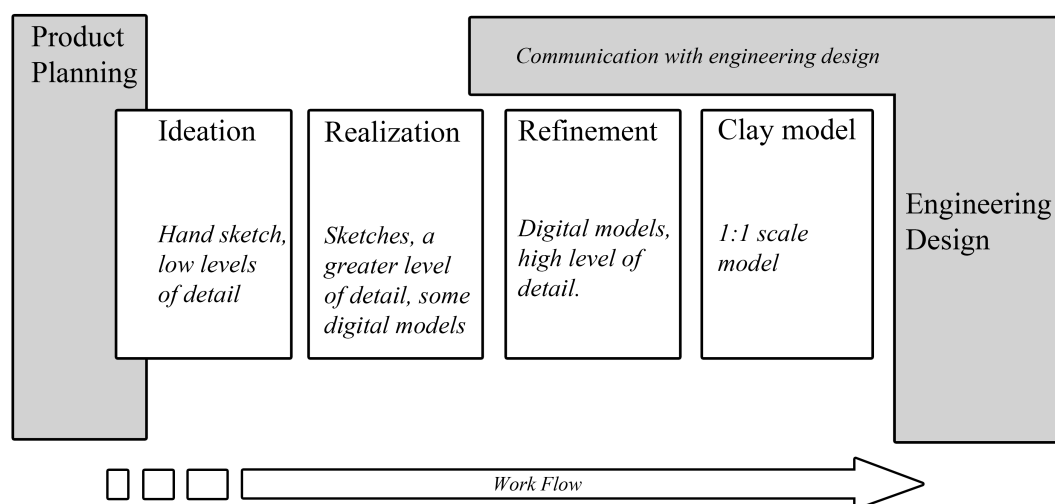
Over the past twenty years the design process has been researched and a number of models have been proposed to characterise the process undertaken by designers to develop and produce products (Clark & Fujimoto, 1991; French, 1985; Pahl & Beitz,

1996; Pugh, 1990; Roozenburg & Eekels, 1995; Ullman, 2003; Ulrich & Eppinger, 2008). These models differ somewhat in terminology and the definition of activities undertaken at different stages. However, they all share an underlying similarity in their basic structure. All of the models proposed present a process which begins with the specification of a problem that is to be solved following an iterative sequential process of steps. Progression from one step to the next is governed by evaluation at each step as to how well the problem specified at the beginning has been addressed. Throughout this sequence there may be a number of iterations between stages as designs are developed and converge on a final design.

Evaluation of design proposals is highly influential in the design development process as each evaluation guides a proposal through to completion and then defines the point at which a design is complete or finished.

## 2.2 Vehicle design development

Having set the context of the design and development process, stages in automotive design and development concerned with aesthetics of vehicles, commonly referred to as vehicle ‘styling’, are now discussed. As part of initial research into the styling design process, a series of interviews was conducted with industry professionals and educators. Information gathered from these discussions was used to propose the model (Figure 1) summarising the process.



**Figure 1 Model summarising key stages of the styling design process**

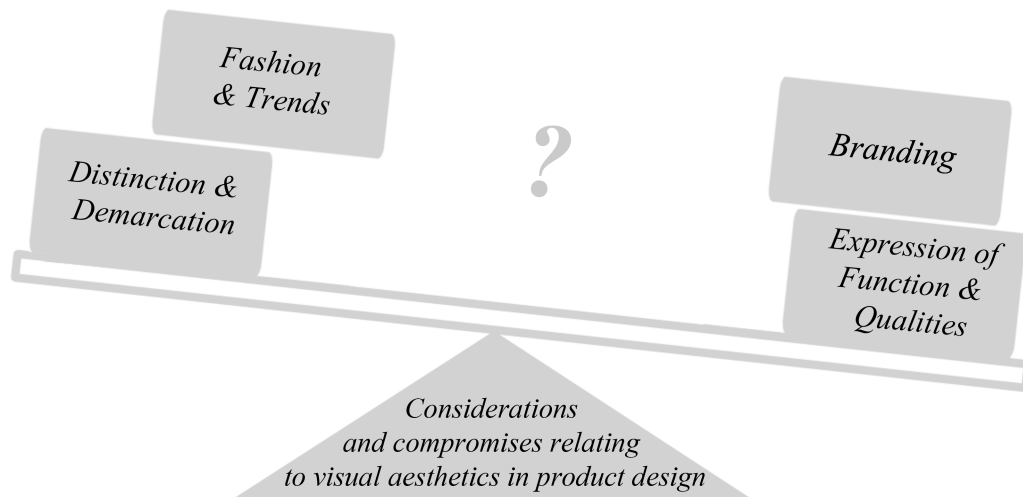
Figure 1 highlights four key stages within the styling design process, ideation, realization, refinement and scale modelling. Figure 1 also details the type of activity within each stage giving pictorial examples of the visual materials produced. From discussions with designers it became apparent that not all design teams or projects follow precisely the same process. This model, however, provides a suitable summary of steps taken in the majority of projects/teams.

As with the generic models for product design and development, it was found that the styling design process also requires points of evaluation for designs to progress and proceed through development. Discussion with industry also outlined the nature of evaluation in the styling design process. Evaluation of proposals was found to be based around the pitching of ideas. Proposals are pitched visually with designers or design teams explaining their proposals and extolling their virtues. Design managers and other stakeholders must then draw on previous experience and their creative

intuition in order to evaluate proposals and select which should be advanced further in the styling design process. Hence it is seen here that evaluation of designs is as necessary as in any other design process, yet it relies almost entirely on subjective assessments of designs.

### 2.3 Visual aesthetics in product design

Holbrook (1986) states that in modern society, aesthetic aspects are relevant to all products regardless of their function. Bloch (1995) acknowledges the influence of visual aesthetics on consumers' decisions to purchase products, stating that given the choice between two products, equal in price and function, consumers purchase the one they consider to be more attractive. As a consequence, the influence of aesthetic aspects of products and the role of aesthetics forms a sizeable body of research. This research can be summarised with respect to four key dimensions; distinction, expression of functions, fashion and trends, and branding which form the basis for evaluating design proposals. These factors are illustrated in Figure 2.



**Figure 2 Illustration of considerations and compromises made by designers when assessing visual aesthetics in products**

- Distinction and demarcation – This factor refers to the use of aesthetics to differentiate one product from old or competing products (Person et al. 2008). Further to this Moulson and Sproles (2000) discuss the degree to which aesthetics should be differentiated to achieve maximum product success.
- Expression of Function and Properties- This factor concerns consumers' ability to gauge function of the product (Norman, 2002), its properties (Monö, 1997) and furthermore to identify and recognise the product from these attributes (Crilly et al. 2008).
- Fashion and trends – Fashions are defined as shifts in the social meaning of aesthetic characteristics (Cappetta et al. 2006). Hence this factor considers the current and future meanings which may be associated with aesthetic characteristics of design proposals.

- Brand – It has been shown that perception of visual aesthetics impacts greatly on perception of brand (Bloch, 1995; Karjalainen, 2003; Page & Herr, 2002). Hence, this factor refers to the consideration of perceived brand of a design proposal.

The evaluation of these four dimensions of visual aesthetics is both highly subjective and multifaceted and as a consequence poses a high area of risk and uncertainty for vehicle manufacturers. It follows that there is implicit requirement to support designers. Such tools need to provide support for designers when evaluating the visual aesthetics of design proposals, and in particular, provide more quantitative reasoning on the relationship between brand and visual aesthetics. Central to achieving this is the need to establish whether a relationship exists between brand and visual aesthetics, and if so, which features are the most potentially representative. The research discussed in this paper addresses this need by creating a strategy to decompose, identify and isolate constituent geometry of visual aesthetics and explore potential consumers' ability to recognise brand.

### *3 A review of visual decomposition strategies*

A number of major studies have been conducted exploring the decomposition and isolation of product images in order to gain a better understanding of the visual material. The approaches are discussed highlighting merits and drawbacks of different methodologies adopted.

#### *3.1 Isolating geometry in drawings*

Biederman (1987; 1988) conducted studies decomposing line drawing representations of products to explore human understanding of images. In his initial study Biederman (1987) decomposed images of products in a variety of ways and showed the decomposed images to participants measuring the length of time it took for them to correctly identify the product. In the first study, the decompositions of images were based around the removal of parts of line elements that constituted the image. Using this approach it was possible to explore which lines or segments of lines were most important for human recognition and understanding. It was found that vertices in line representations of products were most influential for human understanding. This was demonstrated in the way that respondents could not identify products when vertices were degraded, yet could identify products where mid-segments were removed. In a secondary study (Biederman & Ju, 1988) the differences between understanding of line representations of products and representations which include surface details was explored. Participants were shown pictures of products isolating surface and edge parts of the images. This study verified the findings of the initial study as it was found that edge properties have far greater impact on human understanding of objects.

The relevance of these studies to the research discussed in this paper is primarily in the experimental method adopted. They demonstrate that a strategy of decomposing

images to varying degrees is a suitable approach to exploring the effects of constituent features of a product on human perceptions.

The work of Prats et al. (2006) in exploring designers' sketches demonstrates a similarly suitable approach to visual decomposition. The aim of this research was to enhance designers' creativity when sketching by developing a tool to generate shape explorations. In order to develop such a tool the strokes and transformations made by designers while sketching were decomposed and isolated. This approach to visual decomposition provided further insight into the influence of particular elements of sketches on the generation of product form, for use in the development of generative sketching tools.

Related to this study is work by Tovey et al. (2003), considering sketching in automotive design and the technique of 'de-layering' to visually decompose drawings. The de-layering process consisted of decomposing sketches made by students and professionals into 'form lines', 'components', 'form shading' and 'non-form shading'. The study showed the form lines to be most expressive and carry the intentions of the designer. Where Prats and Biederman present methods to decompose line representations of products, the work of Tovey differs in that it presents a method to visually decompose images including richer detail and more realistic details such as those from shading surfaces.

Cleveland (2010) investigates the role of aesthetics in graphic design styles. A methodology was proposed to aid designers by reproducing graphic layouts within the same aesthetic style. In creating this methodology, Cleveland decomposes layouts classed as belonging to a particular style by the geometric relationships between constituent features. Relationships include proximity between features and their placement within a page. Trends identified in geometric relationships form the rules by which layouts may be automatically generated. While this research is not directly applicable to products due to the two dimensional nature of graphic design, it does illustrate the way in which geometric rules can be used to characterise visual aesthetic styles.

### *3.2 Identifying aesthetic features*

The FIORES projects, part of the EU information technology collaboration portfolio, aimed to improve the working procedures and computer aided tools for modelling aesthetic shapes (Cheutet, et al., 2008) by studying 'aesthetic key lines'. These were defined as lines on a vehicle surface that were thought to be aesthetically important. The aim of the study was to help preserve the original design intent through the complete vehicle design process. Previous work defined curve geometries in the terminology used by stylists (Podehl, 2002). The decomposition strategy used in this study was based on isolating 'aesthetic key lines' from front side and rear views of vehicles. The isolated lines were then reviewed with respect to the terminology and curve geometry. Data was used to create an ontology of curves linking quantitative properties from digital models with aesthetic properties based on stylists' terminology. The key relevance of this study to the current research, is the identification, extraction and isolation of aesthetic features of vehicles.

In a similar manner, the works of Pugliese and Cagan (2002) and McCormack et al. (McCormack et al. 2004) investigate the use of shape grammars to generate designs for motorcycles and cars that contain brand specific aesthetic features. A shape grammar is a term used to describe a set of geometric rules that can be applied to create geometry in a particular style. In order to create a shape grammar adhering to a particular aesthetic style, the aesthetic features of existing product had first to be explored. This was done by first simplifying images into two dimensional line representations. Shape grammars were then used to generate a range of alternate concepts experimenting with aesthetic features and recognition of brand. As well as adopting an approach of visual decomposition to explore aesthetic features, this research also shows that simple 2d line representations of vehicles can still contain enough visual information to portray some degree of aesthetic characteristics when conducting visual decompositions.

Warell (2001) addresses the concept of visual decomposition of products. In this thesis Warell explores the nature and workings of visual aesthetics to support development of product form. Within this study Warell visually decomposes images of products, defining constituent aesthetic features as belonging to different categories termed 'form entities'. These are defined by their 'visuo-spatial' configurations (how they appear with respect to other aesthetic features). Having categorized product features as belonging to different form entities, the perceptual effects of aesthetic features (syntactic function) were investigated. Doing this was said to enhance understanding of form, structure, content and composition in the design of products.

Warell's work demonstrates yet another approach for visually decomposing images to better understand aesthetic features in product designs. Warell further verifies this decomposition technique in further studies (Warell, 2004; Warell, et al., 2006), where decomposition of products by form entities was used to explore consumer perceptions of alternative product designs.

Karjalainen (2007) also explores the aesthetic properties of vehicles and their branding through visual decomposition. A range of vehicles of a particular brand was visually decomposed in order to identify explicit visual references. Explicit visual references were defined as references embedded within design features, implemented by designers with the intention of being easily recognized and perceived as being of a particular brand. The explicit visual references identified were then used as a basis for designing different products but still identifiably of the same brand. Results showed that such analysis of the product range and isolation of features could be used as a basis to design products exhibiting distinct brand features.

Liem et al. (2009) present a further study into recognition of and expression in aesthetic features of vehicle form. This study aimed to explore how recognition is formed by visual elements in vehicle form. In order to achieve this goal Liem et al. decomposed different view of a vehicle into individual components. Next a group of designers were asked to highlight the components they thought to be most expressive and thus able to trigger recognition. Although this study does not decompose images to the point of isolating components for further investigation, it provides a valuable example of a strategy to identify types of visual features that constitute vehicle form which could be decomposed.



While all of these aforementioned strategies are relevant to this work in that they present approaches to visual decomposition of products, no single approach shall be adopted for the purposes of this investigation. Rather, elements from studies shall be drawn on and developed to form the visual decomposition approach for vehicles used in this study.

## *4 Proposed visual decomposition strategy for vehicle images*

The strategy proposed draws on studies discussed in section 4, as well as understanding gathered from practicing designers on the characteristic processes used to create the aesthetic features in designs. This information was gathered through a series of interviews and presentations with practicing designers from GM Holden Australia, Nissan design Europe, Shado and IAD automotive design consultancies, as well as with automotive design educators and students.

These interviews revealed that, in order to generate research findings that are relevant and valuable for use in the styling design process, the steps taken by designers should be considered in the development of a decomposition strategy. Hence the strategy created here is based in the sketching activity and steps taken by designers during ideation and realization stages (section 2.2, Figure 1) to create overall vehicle form. From interviews the following types of aesthetic features are defined.

*Outline:* This is the boundary created between the vehicle and space surrounding it. It could also be termed the silhouette. During design the outline defines the vehicle's general dimensions or 'volumes'.

*Daylight Opening (DLO):* This is defined by the front and rear windshields and side windows. The DLO is also referred to as the greenhouse. In terms of constructing the design of a vehicle and its overall appearance, adding the DLO defines the posture or stance.

*Muscles:* These are treatments given to surfaces or panelling. These are often in the form of creases or curves created by raising or lowering sections of the surface. Such surface treatments are also referred to as character lines or light lines.

*Graphics:* These are described as markings on the vehicle. These included details such as headlamps, radiator grille and number plate. The addition of graphics to a design is usually the final step in creating a proposal.

*Explicit detail:* This is a sub category of graphics. It is made up of graphic features which explicitly indicate vehicle brand, such as badges and logos.

Similar definitions are also seen in literature. Cheutet et al.(2008) and Tovey et al. (2003) make reference to muscles as surfacing that determines character lines and their importance to overall aesthetic. Warell (2001) defines overall outline or silhouette, connecting features manifested in the surface treatment (muscles) and

discrete or discerning features (graphics), further reinforcing the suitability of the visual decomposition strategy.

#### *4.1 Representation of products for visual decomposition*

Having defined the strategy that is to be used to visually decompose aesthetic features, the method of representation of decomposed products is next addressed. For the purposes of this investigation a 2d line representation of vehicles will be used. It is acknowledged that this representation of aesthetic features does not communicate in the same way as the complete product in real life. However in light of studies reviewed in section 3, 2d line representations are said to contain enough detail to provoke recognition. Furthermore it is asserted that there are many instances in product advertising where brand can clearly communicated without complete and realistic product images. The representation of vehicles in this study will be achieved by tracing edges and outlines directly from images using chains of cubic B-spline curves. The decomposition strategy was implemented using the following steps.

- High resolution digital photographs of vehicles were taken from front, side and rear views. Photographs were taken in such a way that lens distortion was minimized thus keeping the geometry represented in photographs as close to that which would be seen by the human eye.
- Using Photoshop image editing software, light conditions were accentuated to highlight ‘muscles’ features in the surfacing of the vehicle making them easier to isolate.
- Chains of 3<sup>rd</sup> degree B-spline curves were used to trace aesthetic features. All features were represented with closed loop curves, with the exception of ‘muscles’ features which were predominantly open curves.
- Isolated features were then layered together to create the combinations of feature categories shown in images used in the survey.

Figure 3 shows examples of the implementation of the vehicle decomposition strategy. . In each view feature categories are successively included, building up the image to form a complete representation.

Feature Category	Outline	Outline DLO	Outline DLO Muscles	Outline DLO Muscles Graphics	Outline DLO Muscles Graphics Explicit detail
Front					
Side					
Rear					

**Figure 3 Illustration of decomposition strategy showing feature categories into which aesthetic features may be decomposed into**

## *5 Implementing and testing the visual decomposition strategy*

As previously stated, the aim of the proposed decomposition strategy is to isolate different categories in order that the influence of different aesthetic features on consumer recognition of brand may be assessed. In order to evaluate the potential of the proposed strategy, and provide an insight into the potency of categories of aesthetic features on brand recognition, a consumer survey was undertaken.

### *5.1 Approach*

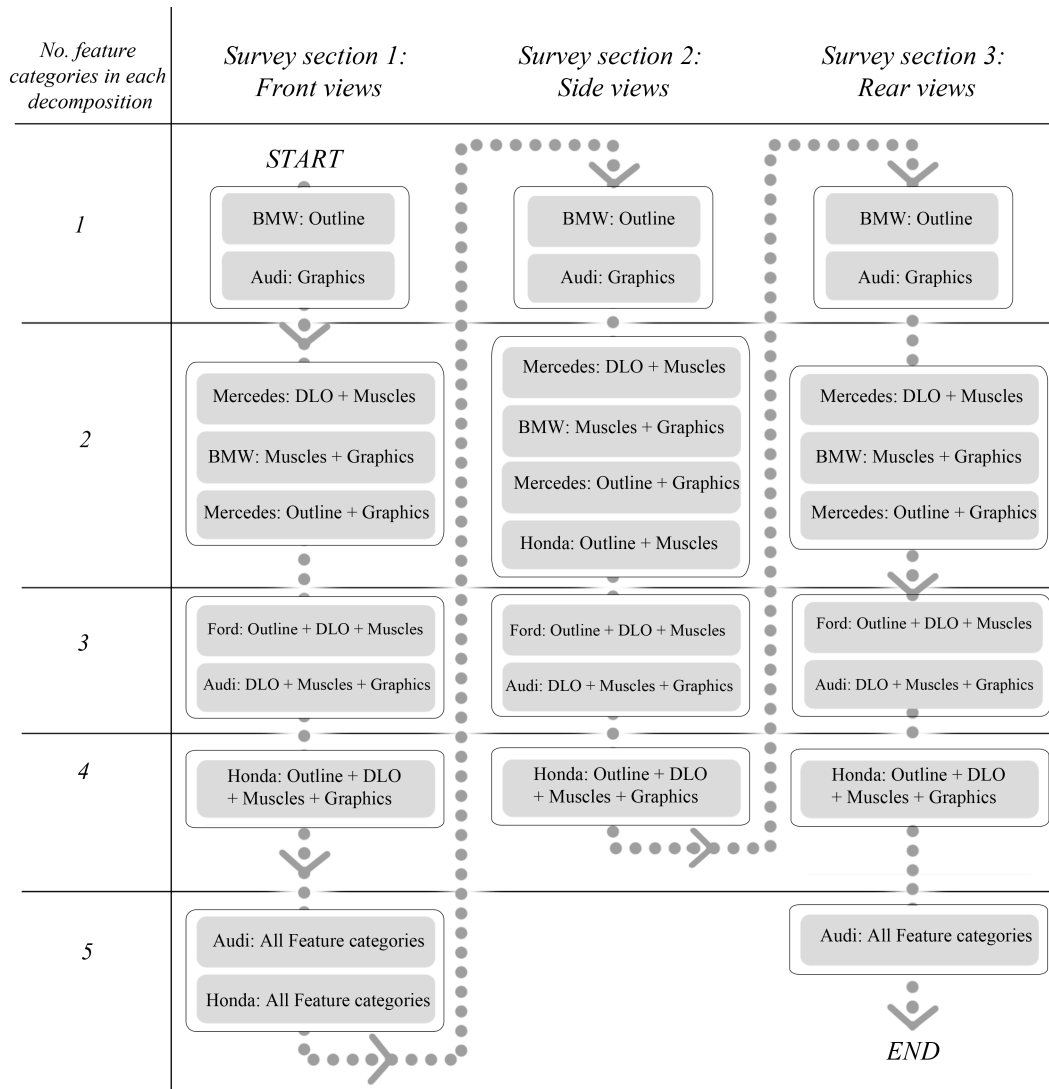
A web based survey approach was employed in order to obtain a large participant population (400 plus). It was also easier to distribute and collect data compared with paper surveys. In terms of responses that participants give to questions, a web based survey is far more rigid compared with paper survey or focus groups. Web based surveys offer little opportunity to provide extra information or further thoughts on responses. It is thought that the advantage in the ability to reach a greater sample size outweighs the possibility to capture participant reaction.

### *5.2 Selected brands vehicles*

Five vehicles were visually decomposed for use in the survey, BMW 3 Series, Audi A4, Mercedes-Benz C-Class, Ford Mondeo, and Honda Accord saloon models all from the same year. These vehicles were chosen because they were found to be in direct competition in terms of size, segment and price (Which?Car, 2010). Furthermore all of the vehicle brands were found to be in the top 100 global brands chart of 2009 (Interbrand, 2009).

### *5.3 Survey structure*

The structure of the survey is based on displaying decomposed images of front, side and then rear views of vehicles. These formed three sections of the survey. Using five vehicles meant that there were 240 possible decomposition images (sixteen possible combinations of decompositions per vehicle, using five vehicles, in three different views). Including all of the images would result in an exceptionally lengthy and repetitive survey (given 20s per image,  $240 \times 20 = 4800\text{s}$  or 80min) that few participants would take the time to complete. Some combinations of feature categories, especially those containing explicit identifiers, were thought to give away answers to subsequent questions. Other decomposition combinations were deemed to be so obscure that any correct identification would likely be down to luck. As a result, a sequence of 38 decompositions was selected (Figure 4). This would show most of the feature category combinations using a variety of vehicles yet avoiding explicit vehicle identification too early in the survey. To further avoid invalidating responses by giving away brand identity, in each view (front, side, rear) the number of aesthetic features included in decompositions increased from one to the complete image. The sequence of decomposition images shown to participants is illustrated in Figure 4.



**Figure 4** Sequence and details of decomposed images shown to participants

A number of points should be highlighted when viewing the sequence of images shown to participants. Firstly it can be seen that the same combinations of features on the same vehicles is used in all three sections/views. This was done for the purpose of consistency and comparability of results between the different views. However, it can also be seen that there are instances where the images deviate from this sequence. When visually decomposing the side view of vehicles, there were found to be no ‘explicit identifiers’. Hence, there could be no decompositions that included all five feature categories. Consequently a further decomposition including two feature categories was included (Honda: Outline + Muscles).

#### 5.4 Questions

As the purpose of the survey was to explore the influence of aesthetic feature categories on brand recognition, the primary question posed aims to test participants’ ability to identify vehicle brand. Further insight into what participants recognise from different decompositions is obtained by secondary questions concerning physical and subjective attributes that characterise the product. Three questions were posed to participants in a multiple choice format for each decomposition. Table 1 shows the possible choices given to participants to select an answer from.

Question Posed	<i>'Which brand manufactures this car?'</i>	<i>'In which segment does this vehicle belong?'</i>	<i>'Which emotions best describe this vehicle's character?'</i>
Possible answers	Not Sure Audi BMW Citroen Fiat Ford Honda Mercedes Benz Nissan Renault	Not Sure City Car Small Car Medium/Family Car Large/Estate Car Executive Car Luxury Car SUV/4X4/Off road vehicle MPV/People Carrier Sports Car	Not Sure Aggressive Dynamic Elegant Friendly Modern Powerful Sporty Stable

**Table 1 Questions posed to participants with respect to decomposition images and multiple choice answers**

The rationale for presenting participants with this range of answers was to include all characteristics that describe the five vehicles used in the survey, while adding additional options to reduce the probability of correct identifications from 'stab in the dark' guesses. In addition to questions concerning each decomposition, a series of profiling questions were posed. These questions concerned information about participants such as age, gender, a self-assessment of their ability to recognize vehicle brand and exposure to vehicles. Thus, participants were asked to record whether or not they held a drivers licence and for how long, how many hours they spent driving per week and their interest in brand and styling of vehicles. Participants were also asked to rate their confidence in their ability to identify the brand of a range of vehicles.

## 6 Results & Discussion

The survey was made available online for five days from 2<sup>nd</sup> March 2010. A total of 420 responses were recorded. Respondents were aged between 17 and 63 years old. 78% of responses were recorded by male participants and 22% by female.

With respect to the exposure of participants to vehicles, 89% of participants held a drivers licence and have had it for an average of 8 years. The average number of hours spent driving per week was 5.7 hours with a maximum of 65 hours.

The profiling questions revealed that 49% of participants held a car's styling as being 'very important' when considering purchasing a car while 43% responded 'mildly important' and 8% responded 'not important'. It was also found that 36% of participants held vehicle brand as being 'very important' when considering purchasing a car, while 50% responded 'mildly important' and 14% responded 'not important'. Finally it was found that from the vehicles included in the survey participants were most confident in their ability to identify BMW, with Mercedes second, Audi third, Ford fourth and Honda last.

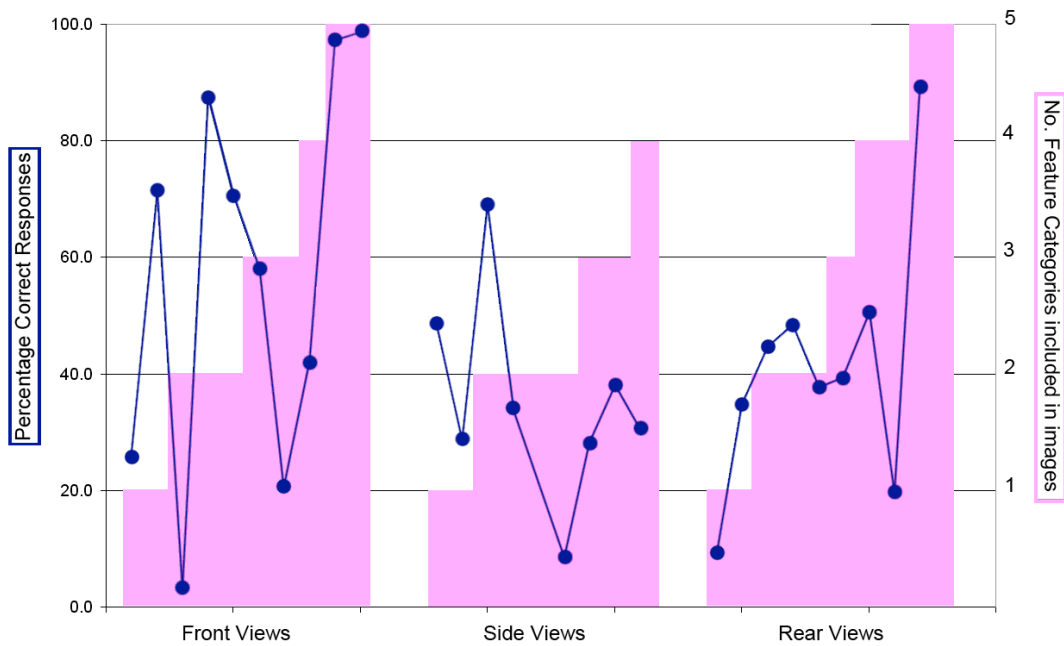
From data collected in the survey the following primary observations were made:

- 1. Number of correct responses is not proportional to the number of feature categories included in each image.
- 2. There are more correct responses to questions posed with respect to front views and less correct responses with respect to side and rear views
- 3: Participants appear to find it harder to recognize vehicle segment and vehicle character compared with their ability to recognize brand
- 4. No obvious correlation exists between side and rear views of the same vehicle and feature categories.
- 5: Images which return the greatest number of correct responses to brand are of the front view and include the 'Graphics' feature category.

When looking at results, it can be seen that there is no obvious pattern as to which vehicles and combinations of feature categories are consistently recognized by participants (save for those including explicit aesthetic features). On the contrary there is significant variation in number of correct responses (3% - 90% correct responses to different decompositions). This variety in responses suggests that certain images inspire different levels of recognition in participants indicating that the information communicated through the simplified 2d line form is rich enough to elicit different types of response in participants. Thus, although the representations of vehicles suffer from a relatively high level of abstraction, they can still be correctly identified.

### *6.1 Influence on responses of increasing number of feature categories in decompositions*

From the results it can be seen that displaying different combinations of feature categories elicits varying recognition of brand (primary observation 1). Over the course of the survey the number of feature categories that make up an image increases, hence as participants progress through the survey they are given increasing levels of information. However and somewhat surprisingly, the number of correct identifications of brand and vehicle characteristics did not increase proportionally with the increasing level of information (number of feature categories included) in each image (Figure 5).



**Figure 5 Demonstrating the lack of any correlation or trend between percentage of correct identifications of brand and the increasing number of feature categories included in images.**

Conducting a Chi-test on survey data confirms the trend suggested by Figure 5. The value for  $X^2$  tends to zero in front, side and rear views showing that the percentage of respondents correctly identifying brand is independent to the number of feature categories included in decompositions.

The brand of decompositions containing all feature categories is correctly guessed by a large percentage of participants (Figure 5). This is explained by the presence of ‘explicit detail’ such as logos in decompositions. In all views it can be seen that decompositions containing only one or two feature categories also repeatedly receive a greater percentage of correct responses than decompositions containing three or four feature categories. This pattern suggests that different feature categories have greater influence participant’s perception of brand than others.

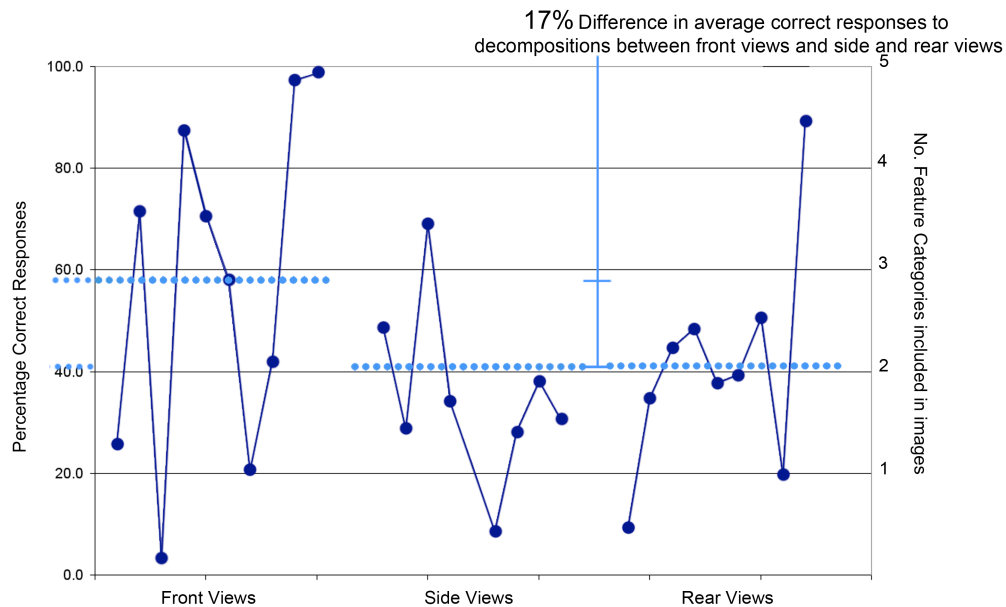
## 6.2 Significance of views

It is also noticeable that there are more correct identifications of vehicle brand and characteristics in images showing front views of vehicles (primary observation 2). The average percentage of correct responses to front views is 58%, while the average percentage of correct responses to both side and rear views is 41%. These findings are concurrent with literature which states that the front view of vehicles are the most central single element for incorporating brand references (Chen et al. 2007; Karjalainen, 2004). Thus, this experimentation confirms the idea that aesthetic features in the front view have greatest influence on consumer perception of brand.



		<i>View</i>			<i>Question</i>		
		<i>Front</i>	<i>Side</i>	<i>Rear</i>	<i>Brand</i>	<i>Segment</i>	<i>Character</i>
<i>Avg. Correct Response</i>	<i>%</i>	58.1	41.0	41.0	50.6	33.0	32.5

**Table 2 Summary of the average percentage of correct responses to decompositions with respect to view shown and questions posed**



**Figure 6 Illustrating that more respondents guess brand correctly when shown front views of vehicles**

### 6.3 Responses to different types of questions

Throughout the survey, participants achieve less correct responses to questions on segment and character than to questions on brand. This is demonstrated by the average percentage of correct response to questions relating brand was 50.6%, while average percentage of correct responses to questions on segment and character was 33.0% and 32.5% respectively (Table 2).

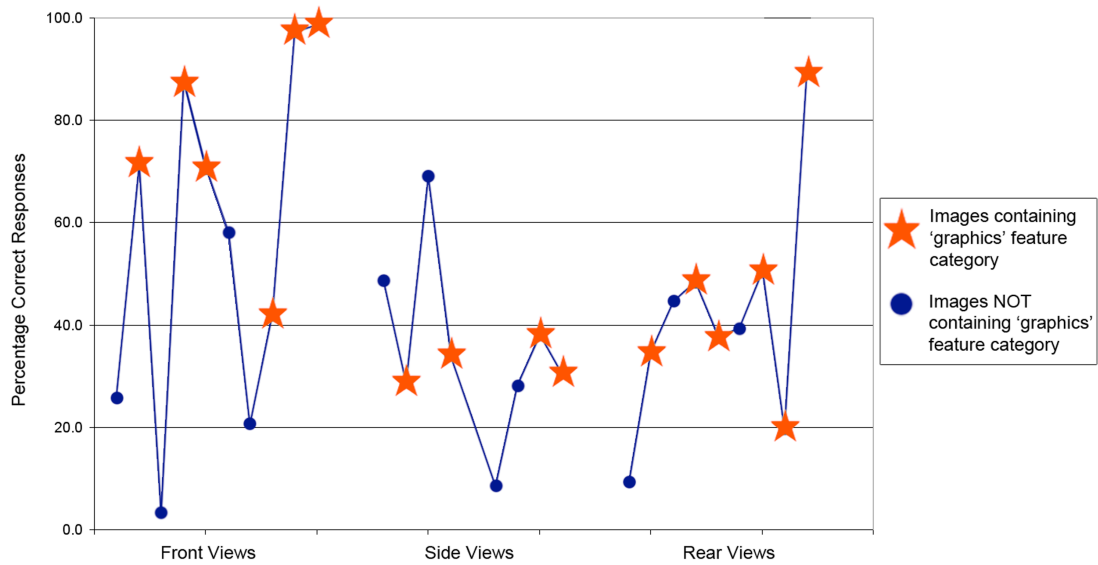
It is asserted that the reason for such a low average percentage of correct responses to questions on vehicle character was due to the abstract nature of questions posed. It is thought that verbalizing vehicle's emotional character was found by participants to be difficult, especially in reference to the low detail images and with a time constraint. This could be tested and improved by repeating the survey using images with greater level of detail.

The majority of responses to vehicle segment were also incorrect. This was especially surprising for side views as it was thought that the vehicle outline and DLO would clearly indicate segment. It is thought that the explanation for these results is that terminology used to define segment, although technically correct (based on EuroNCAP classification (1999)) was somewhat ambiguous. Further experimentation asking participants to identify segment pictorially could be undertaken to remove this ambiguity.

As an exception to this in which the side-view of the Mercedes including DLO and muscles feature categories is correctly identified by substantially more participants than other combinations of feature categories. The existence of this exception suggests that there is some element of this combination of aesthetic features that make it more recognizable and thus worth investigating further.

#### 6.4 *Influence of different feature categories*

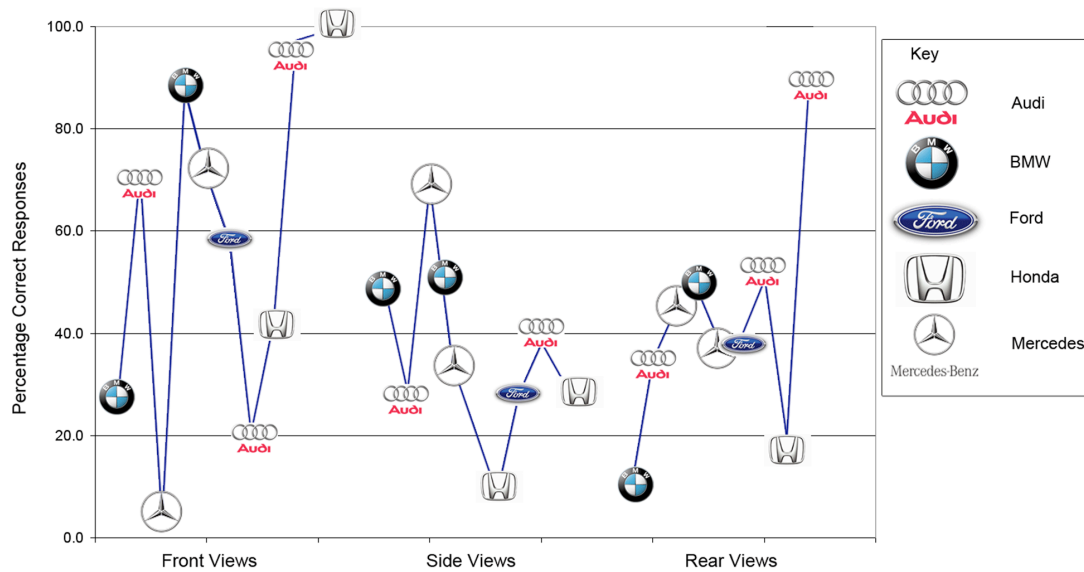
As previously stated, some feature categories have greater influence on ability to identify vehicle brand than others. On closer inspection of decompositions returning greater percentage correct responses, it can be seen that many of the decompositions contain the ‘graphics’ feature category (Figure 7). This suggests that the graphics feature category in the front view is more potent in communicating vehicle brand.



**Figure 7** Illustrating Images containing 'Graphics' feature category in the front view receive more correct responses

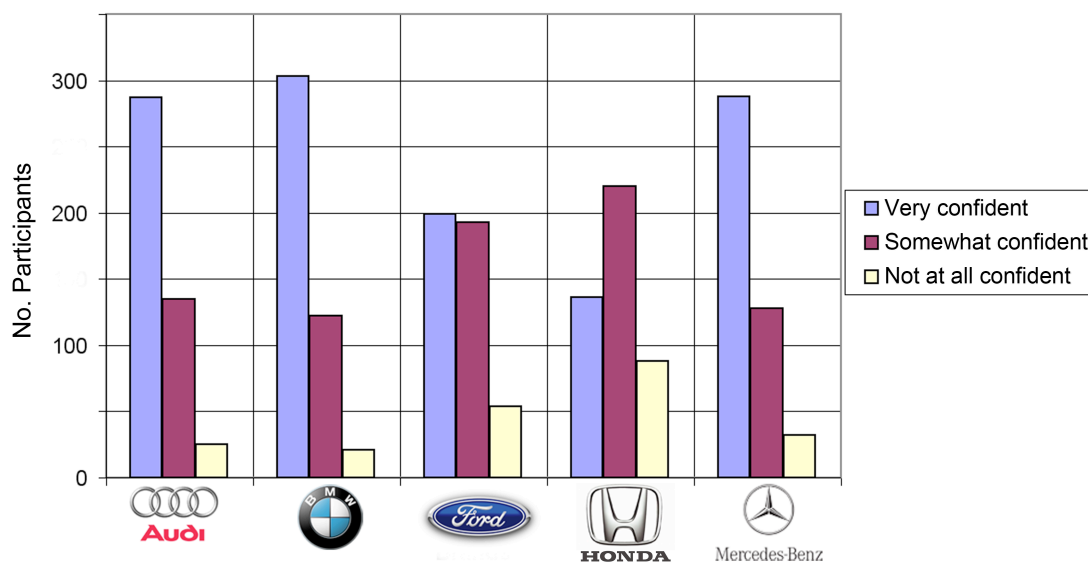
#### 6.5 *Influence of brand name*

When analyzing responses to different feature categories within specific vehicles, (eg. the BMW in isolation), no common pattern can be seen (Figure 8).



**Figure 8 Illustrating the range of correct responses with respect to vehicle brand**

In other words, when the number of correct responses at different levels is looked at for specific vehicles, each vehicle exhibits a different trend. This is because none of the vehicles share common feature category combinations, as these were limited by constraints on the time and length of survey. It would hence be worthwhile extending this survey as part of further work to investigate potential patterns in visual breakdown of specific vehicles.



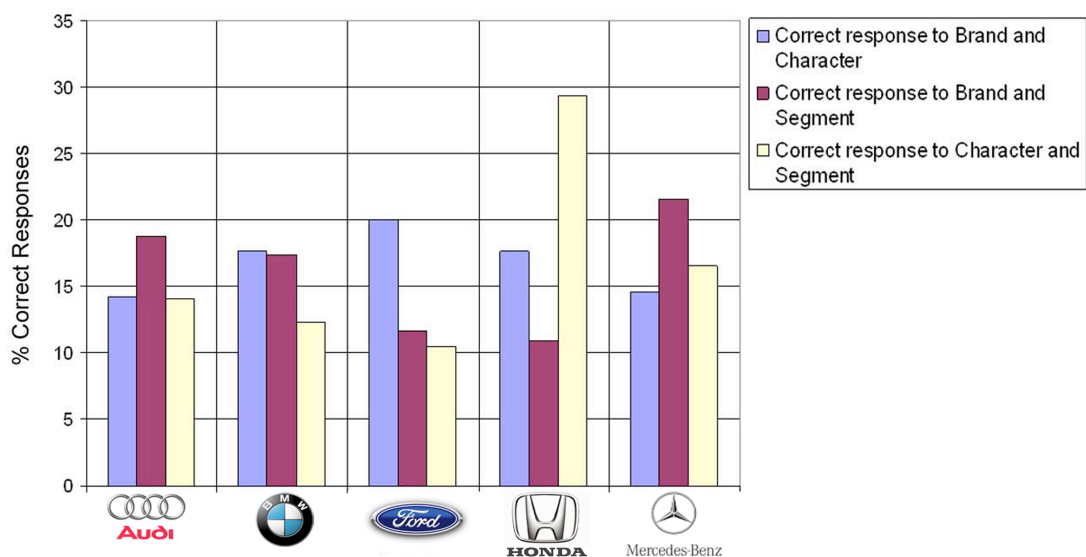
**Figure 9 Participants' confidence in recognising different vehicle brands**

Results from the profiling show that participants were the least confident in their ability to identify 'Honda' and 'Ford' brands. This is reflected when comparing correct responses with respect to the five vehicle brands used. It can be seen that there are less correct identifications of these brands and their characteristics. It is inappropriate to draw further conclusions from this basic observation because, as with looking at trends relating to individual vehicles, these brands made limited appearances during the course of the survey.

## 6.6 Influence of participants familiarity and exposure to vehicles on responses

A multivariate analysis of results was conducted including information gathered in the profiling stage of the survey. This was done to ascertain whether the effect of participant's prior knowledge of, and exposure to vehicles had any effect on participant's ability to identify vehicle characteristics. Broadly, of the participants correctly identifying vehicle characteristics, the proportions of age, gender, confidence in identifying brands and interest in styling reflected those of the total participant sample. As would be expected, it was found that participants who could drive and spent longer per week on the road answered a greater proportion (5%) of questions correctly than those who did not.

A further multivariate analysis was conducted to investigate the distribution of correct responses in the condition of a correct response to another question. For example, investigating distribution of responses to questions on vehicle segment where participants had correctly answered questions on vehicle brand. This was done to investigate whether participants associated certain vehicle segments or characteristics with brands when attempting to answer questions. The three possible combinations of two feature categories (brand and character, brand and segment, character and segment) were reviewed for each of the five vehicles used in the study. The distribution of correct responses is illustrated in Figure 10.



**Figure 10** Multivariate analysis on responses to different vehicle characteristics

As different vehicles were shown to participants a different number of times during the surveys, correct responses are shown as a proportion of the total number of responses to each vehicle. Based on Figure 10 it can be seen that there is no clear trend for participants to consistently answer one type of question correctly having answered another type of question correctly. For example, participants do not always guess segment correctly if they guess brand correctly. This is also demonstrated in that the proportion of correct responses is mirrored by the overall percentage of correct responses to segment and character shown in.

The ambiguity in possible answers that is contended to have potentially affected participants' responses to questions on segment and character is also considered in

this analysis. It is possible that, due to this ambiguity, participants may have clear ideas of vehicle segment and character however these were not recorded. Thus it is not possible to draw any clear conclusions as to whether participants associate certain types of vehicle segment or emotional characteristic with brand.

## *7 Conclusions*

Appearance is one of the influential factors leading to a successful product. It has also highlighted a difficulty faced by designers and managers in evaluating aesthetic features. In this study vehicles were visually decomposed into constituent aesthetic features. In order to explore and better understand their influence on consumer perception of brand, combinations of features were assessed using a web-based survey. A number of conclusions are drawn.

Firstly the proposed method of visually decomposing images of designs into feature categories was successful in exploring the way different aesthetic features affect recognition of brand. This was demonstrated by the distribution of correct and incorrect responses over the course of the survey. This also indicates that the representation of products adopted for this study contains an appropriate amount of detail for consumers to correctly identify brand. Of those in the front view of a vehicle are most easily recognized by participants.

The second key conclusion is that different combinations of feature categories have different potency in representing brand. The graphics feature category holds the greatest potency in representing brand. This was shown in participants' responses to image of the front view which included 'Graphics' (headlights and grille detail) producing far more correct responses than those without. Due to the varying potency of different geometries it can be further concluded that it is not the sum of information included in feature categories that influence responses but the potency of geometries included.

It is also seen that the concept of visual decomposition provides a platform on which to explore the relationship between aesthetic features and consumer perception. The work also suggests that this method could be applied to investigate a particular feature in further detail.

The decomposition strategy proposed and used here, although useful in highlighting features most potently representing brand, does not provide designers and managers with decisive guidance when faced with a range of similar design proposals. What is needed are numeric metrics against which decomposed aesthetic features may be measured. These would give designers and managers scales by which to review aesthetic aspects of a design in the same way that they may be used to review technical aspects of a design. In doing so, decisions regarding the (ever) increasingly crucial aspect of product aesthetics, could be made with less risk.

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